PREHISTORIC REMAINS OF THE SWEET POTATO

FROM THE CASMA VALLEY OF PERU

Donald Ugent,[1] Shelia Pozorski,[2] and Thomas Pozorski[3]

Archaeological samples of the sweet potato (Ipomoea batatas Lam.) have been previously unearthed in the New World from only eight sites in central and south central Peru. Seven of these sites are on the desert coast. From the middens of Pachacamac and the Ancon necropolis have come specimens of tuberous roots dating from the Late Intermediate Period, A.D. 1000-1500 (Safford, 1917; Wittmack, 1880-1887); the burial fields at Paracas and Ocucaje in the Ica Valley and Cahuachi in the Nazca Valley have yielded plant remains from the late Early Horizon, 750 B.C.-A.D. 1 (Strong, in Towle, 1961; Tello, in Nordenskiold, 1931). Specimens from the late Cotton Preceramic period (1900-1750 B.C.) are represented by excavated collections from the central coast sites of Punta Grande and Tank Site, and Tank Site also yielded sweet potato in the subsequent early ceramic levels (Patterson, 1971; MacNeish et al, 1975; Cohen, 1978; Lanning 1965 and 1967; Patterson and Moseley, 1968).

The oldest specimens of the sweet potato so far known to science have come from the highland caves at Chilca Canyon, located some 65 kms south of Lima and at an altitude of over 2800 m. Radiocarbon dates associated with materials found along with three dried sweet potato roots suggest the caves were first occupied about 8000 B.C. (Engel, 1970).

Other chronologically much more recent remains of the sweet potato, dating from A.D. 800 to 1600, come from Easter Island, New Zealand and Hawaii. These collections, as well as current theories regarding the pre-Columbian introduction of the sweet potato from its putative homeland in Peru to the islands of the Pacific, are discussed at some length by Brand (1971), Yen (1971, 1974), O'Brien (1972) and Heyerdahl (1952, 1958).

In the present work, a collection of 18 roots of the sweet potato that were unearthed from the middens of one Preceramic (2000 B.C.) and two Initial Period (1800-1500 B.C.) sites situated near the coastal desert city of Casma in the Department of Ancash, Peru, is described. These samples represent the northernmost archaeological collections of this plant thus far known to science. The roots were positively identified as belonging to that of the sweet potato by their extant surface features and by their starch grains, which are unlike those known for any other cultivated root crop species.

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[1] Associate Professor of Botany, Southern Illinois University, Carbondale, IL 62901

[2] Honorary Assistant Curator, Section of Man, Carnegie Museum of Natural History, 4400 Forbes Avenue, Pittsburgh, PA 15213.

[3] Assistant Curator, Section of Man, Carnegie Museum of Natural History, 4400 Forbes Avenue, Pittsburgh, PA 15213.

The plant remains described in this study derive from an on-going archaeological project of the second and third authors, and the material is currently in this country on loan from the Peruvian Instituto Nacional de Cultura. As additional collections of the sweet potato may be expected from future archaeological probings in this valley, the current study, as here set forth, must be considered as only preliminary.

ARCHAEOLOGICAL SETTING

Of the three sites in the Casma Valley where preserved remains of the sweet potato have already been found, the largest and most impressive in terms of areal extent and range of archaeological features is C1, or Pampa de las Llamas-Moxeke. This very early ceramic site is located about 20 km from the coast on the south branch of the Casma River (Fig. 1). It covers an area of about 220 hectares and includes both the mound of Moxeke and another large mound, this facing the first, as well as an extensive area of both small mounds and domestic architecture. Bordering the clusters of domestic architecture are the small mounded midden deposits which were sampled in connection with the present study. Although controlled stratigraphic excavations have been carried out at Pampa de las Llamas-Moxeke, the material available for this study came from a series of one meter square test pits dug into the various middens in order to gain a better understanding of their contents. Pottery and other artifacts unearthed from both these middens and the domestic structures of Pampa de las Llamas-Moxeke indicate that the occupation of this site dates to the Initial Period, 1800-1500 B.C. Specimens one through nine of the present study were found in various features of this site, and the first four of these were associated with tuber remains of the Solanum potato.

The second locality at which remains of the sweet potato have been found is designated C3 and is called Huaynuma. This preceramic site is about three hectares in area and occupies a protected area on a bay north of the Casma Valley (Fig. 1). No architecture is visible on the surface, but as a few walls were encountered during excavation of the site, it is evident that there were preceramic domestic structures and at least one small mound there. Some areas of the midden are up to two meters deep. The samples are from controlled stratigraphic excavations made by natural levels. These levels were numbered from the surface down as they were taken out, beginning with one, and unusually thick levels were divided into 10 to 15 cm artificial levels designated further by lower case letters. The age of the single tuberous root sample of the sweet potato (specimen 10) retrieved from this site is estimated at 2000 B.C. It was associated with plant remains of achira (Canna) and the Solanum potato.

The third site at which the sweet potato was found is called Tortugas and is designated C4. This early ceramic site lies on the coast north of Casma (Fig. 1). Much of the site has been destroyed by modern construction, but an area of midden over a meter deep lies undisturbed and was sampled in connection with the present study. On the basis of ceramics and other artifacts, it is believed that Tortugas is contemporary with

Pampa de las Llamas-Moxeke and dates to the Initial Period, about 1800-1500 B.C. As in the case of the Huaynuma provenience, the samples from Tortugas are from different levels within a controlled stratigraphic excavation. Specimens 11 through 18 are from this site. The Solanum potato was associated with specimen 11, and the Solanum potato and yam bean (or jicama) with specimens 14 through 18.

DESCRIPTION OF THE SPECIMENS

The procedures used in this section of the work for the staining and identification of starch grains are the same as those outlined by Whistler and Paschall (1967).

Sweet potatoes have compound starch grains ranging from 10 to 20 microns in diameter. When placed in water or stained with aqueous iodine solutions, these larger grains break apart into predominantly polyhedral granules, with some rounded (or shell-shaped), cap-shaped and faceted-round granules also present (Figs. 3 and 4). When mounted in glycerine and viewed by ordinary light microscope, or gold-palladium coated and observed by scanning electron microscope (Figs. 5B and C), they are seen to retain their true compound structure.

Also helpful in the identification of sweet potato remains is the presence of characteristic xylem vessel fragments in the starch preparations (Fig. 5D). These elements have sclariform-pitted walls and are quite fragile, appearing usually as bits and pieces of the whole cells in the preparations. Yam beans, which also have sclariform-pitted vessel elements, have a toughened vascular system which rarely comes apart in water. Moreover, the average size of the starch granules of this species are smaller than those of the sweet potato.

Lastly, it should be mentioned that color references in the following descriptions refer to the plates in Maerz and Paul's (1950) work, "A Dictionary of Color."

SPECIMEN 1 (Fig. 2A). Root fragment lacking a tip, irregularly conical, 30 mm long and 20 mm in diameter at the fractured top and 9 mm in diameter at the broken base. Skin rough, cracked and charred, without evident surface features, appearing elk brown (16-A11). Starch grains staining lightly with iodine-potassium iodide solution (Fig. 3A), the color mostly leaving the grains and darkening the surrounding medium. Granule size up to 30 microns in diameter, these appearing dark when stained with methylene blue. Sample weight 2.67 grams. Provenience data: Pampa de las Llamas-Moxeke; C1B-1=13, area B, test pit 9.

SPECIMEN 2 (Fig. 2B). Fragment probably of upper end of root, 28 mm long, 23 mm wide and about 8 mm thick. Skin striated, showing place of attachment of one lateral root, embedded with sand, debris and bits of wood charcoal, appearing gold brown (14-F12), the color of some modern varieties of sweet potato. Interior of root appearing granular, embedded with bits of charcoal. Starch granules staining medium-light with iodine-potassium iodide solution but darkly with methylene blue, the larger up to

30 microns long (Fig. 3B). Sample weight 1.51 grams. Provenience data: Pampa de las Llamas-Moxeke; C1B-1=13, area B, test pit 9.

SPECIMEN 3 (Fig. 2C). Fragment of root, 15 mm long, 11 mm wide and 7 mm thick. Skin striated, embedded with bits and pieces of wood charcoal, the color appearing gold brown (14-F12). Cortex of root granular, embedded with particles of charcoal. The compound starch grains (see SEM photos in Figs. 5B and C) breaking up into granules of about 35 microns maximum size, the granules staining darkly with iodine-potassium iodide solution (Fig. 3C). Weight of fragment 0.32 grams. Provenience data: Pampa de las Llamas-Moxeke; C1B-1=13, area B, test pit 9.

SPECIMEN 4 (Fig. 2D). Root entire, irregularly compressed-conical, with rounded shoulders and pointed tip representing connecting root attachment, 32 mm long, 13 mm wide and 9 mm thick. Skin longitudinally wrinkled and shriveled, embedded in places with debris and small bits and pieces of wood charcoal, the color raquet brown (15-C7). Starch granules staining very darkly with iodine-potassium iodide solution and methylene blue, the largest about 35 mm long (Fig. 3D). Root weight 0.96 grams. Provenience data: Pampa de las Llamas-Moxeke; C1B-1=28, area B, test pit 14.

SPECIMEN 5 (Fig. 2E). Lower root fragment, slightly twisted and irregularly conical, 34 mm long, 15 mm wide and 11 mm thick. Skin rough, wrinkled, cracked and damaged by rot, the color clove brown (16-A7). Cortex color coffee brown (15-A11). A single maggot pupa skin is found partially buried in the cortex of this specimen. Starch granules staining medium-light with iodine-potassium iodide solution and darkly with methylene blue, the larger about 40 microns long (Fig. 3E). Fragment weight 1.93 grams. Provenience data: Pampa de las Llamas-Moxeke; C1C-1=7, area C, test pit 3.

SPECIMEN 6 (Fig. 2F). Fragment of lower root, compressed-conical and slightly twisted, 34 mm long, 14 mm wide and 8 mm thick. Skin rough, cracked and wrinkled, damaged by rot, the color sparrow brown (15-C6). Cortex color mandalay (8-L12). Starch granules staining very lightly with iodine-potassium iodide solution (the color soon leaving the granules and staining the surrounding solution), and darkly with methylene blue, the larger about 25 microns long (Fig. 3F). Fragment weight 2.06 grams. Provenience data: Pampa de las Llamas-Moxeke; C1C-1=7, area C, test pit 3.

SPECIMEN 7 (Fig. 2G). Root entire, fusiform and slightly compressed, 31 mm long, 13 mm wide and 10 mm thick. Skin wrinkled, cracked, charred in some places and embedded with particles of charcoal, with some damage by rot, the color chukker brown (15-C8). Starch granules staining very darkly with iodine-potassium iodide solution, the larger 25 microns long (Fig. 3G). Root weight 1.59 grams. Provenience data: Pampa de las Llamas-Moxeke; C1C-1=7, area C, test pit 3.

SPECIMEN 8 (Fig. 2H). Tip of tuberous root, the fragment irregularly conical, 40 mm long and 29 mm in diameter. Skin longitudinally wrinkled, showing signs of damage by black rot, embedded with sand, debris and bits and pieces of wood charcoal, the color drab or beige (14-B5). Starch granules staining very light brown with iodine-potassium iodide solution

but darkly with methylene blue, the larger about 40 microns long (Fig. 3H). This sample, weighing 4.29 grams, is the heaviest known so far for the sweet potatoes of the Casma Valley. Provenience data: Pampa de las Llamas-Moxeke; C1C-1=7, area C, test pit 3.

SPECIMEN 9 (Fig. 2I). Fragment of upper portion of tuberous root, the shoulders rounded and provided with a short piece of connecting root, 21 mm long, 28 mm broad and 14 mm thick. Skin rough and flaked off in places, the color raquet brown (15-C7). Cortex embedded with bits and pieces of wood charcoal, the color chamois (11-I5). Starch granules staining darkly with iodine-potassium iodide solution, the larger about 40 microns long (Fig. 3I). Fragment weight 2.69 grams. Provenience data: Pampa de las Llamas-Moxeke; C1C-1=7, area C, test pit 3.

SPECIMEN 10 (Fig. 2J). Root nearly entire, compressed-fusiform and somewhat curved, 18 mm long, 8 mm wide and 6 mm thick. Skin present on one side only, rough, wrinkled and embedded with sand, debris and bits of wood charcoal, the color kangaroo brown (16-C6). Cortex color cocoa (7-E12). Starch granules staining darkly with iodine-potassium iodide solution, the larger 35 microns long (Fig. 4J). Sample weight 0.36 grams. Provenience data: Huaynuma: C3A-2=68, cut 2, square 1, level 4b.

SPECIMEN 11 (Fig. 2K). Root fragment irregularly conical, 20 mm long, 17 mm wide and 14 mm thick. Skin wrinkled, cracked, much encrusted with sand, debris and bits of wood charcoal and slightly charred in places, the color clove brown (16-A7). Cortex of root granular, laced with clear white salt crystals of about 1-2 mm in length, these appearing straight or somewhat curved (Fig. 5A). Cortex color castor brown (16-A8). Starch granules staining very darkly with iodine-potassium iodide solution, the larger 40 microns long (Fig. 4K). Sample weight 1.14 grams. Provenience data: Tortugas; C4A-2=39, cut 2, square 1, level 4b.

SPECIMEN 12 (Fig. 2L). Root entire, fusiform and slightly curved at tip, 18 mm long, 10 mm wide and 8 mm thick. Skin wrinkled, flaked off in places and embedded with grains of sand and wood charcoal, the color rose taupe (16-A4). Cortex color burnt umber (15-A12). Starch granules staining lightly with iodine-potassium iodide solution and darkly with methylene blue, the larger 25 microns long (Fig. 4L). Weight of root 0.61 grams. Provenience data: Tortugas; C4A-2=50, cut 2, square 1, level 8.

SPECIMEN 13 (Fig. 2M). Tip of tuberous root, the fragment curved-conical, 13 mm long, 10 mm wide and 7 mm thick. Skin smooth but tending to be papillose, the color rose taupe (16-A4). Cortex granular, embedded with grains of sand and bits of wood charcoal and appearing clove brown (16-A7). Starch granules staining medium-dark with iodine-potassium iodide solution, the larger 30 microns long (Fig. 4M). Fragment weight 0.22 grams. Provenience data: Tortugas; C4A-2=50, cut 2, square 1, level 8.

SPECIMEN 14 (Fig. 2N). Fragment of tuberous root irregularly curved-conical, 12 mm long, 12 mm wide and 4 mm thick. Skin lacking. Surface of cortex embedded with grains of sand, debris and bits of wood charcoal and appearing acorn brown (15-E7). Starch granules staining darkly with iodine-potassium iodide solution, the larger 25 microns long (Fig. 4N). Fragment weight 0.09 grams. Provenience data: Tortugas; C4A-2=84, cut 2, square 1, level 8.

SPECIMEN 15 (Fig. 2O). Root fusiform, twisted and broken at one end, 14 mm long, 5 mm wide and 4 mm thick. Skin rough and pitted and with a single fungal lesion, the color clove brown (16-A7). Starch granules dark staining with iodine-potassium iodide solution, the larger 25 microns long (Fig 4O). Sample weight 0.20 grams. Provenience data: Tortugas; C4A-2=84, cut 2, square 1, level 8.

SPECIMEN 16 (Fig. 2P). Root fragment irregularly curved-conical, 15 mm long, 12 mm wide and 8 mm thick. Skin smooth, charred, the color smoke brown (16-A2). Starch granules staining medium-dark with iodine-potassium iodide solution, the larger 25 microns long (Fig. 4P). Weight of fragment 0.50 grams. Provenience data: Tortugas; C4A-2=84, cut 2, square 1, level 8.

SPECIMEN 17 (Fig. 2Q). Pointed tuberous root fragment, irregularly conical, 14 mm long, 8 mm wide and 4 mm thick. Skin lacking. Cortex granular, containing clear crystals of about 1 mm in length, the overall color of the cortex appearing sparrow brown (15-C6). Starch granules very dark staining with iodine-potassium iodide solution, the larger 40 microns long (Fig. 4Q). Weighing 0.07 grams, this specimen is the smallest sample in our collection. Provenience data: Tortugas; C4A-2=84, cut 2, square 1, level 8.

SPECIMEN 18 (Fig. 2R). Curved lateral fragment of tuberous root, 27 mm long, 24 mm wide and 5 mm thick. Specimen very brittle (broken in two pieces during handling). Skin wrinkled and flaked off in places, appearing sparrow brown (15-C6). Cortex granular, embedded with sand grains and bits of wood charcoal, the overall color yellow biege (13-H7). Starch granules light staining with iodine-potassium iodide solution, the larger 25 microns long (Fig. 4R). Sample weight 0.79 grams. Provenience data: Tortugas; C4A-2=84, cut 2, square 1, level 8.

DISCUSSION

The remarkably excellent state of preservation of the sweet potatoes is due to the extreme aridity and constant climate of the sites from which they were obtained. According to ONERN (1972), the Casma region is one of the driest along the north coast, usually receiving less than 5 mm of rain a year. Tosi (1960) described the area as subtropical coastal desert, and gives the annual average temperature as 18°C.

Despite the low rainfall of this region, it is well known that crops have been grown locally along the various river valleys of the north coast for at least 4000 years (Pozorski and Pozorski, 1979). Initially, the method of cultivation was probably by flood water farming. People from as far away as Huaynuma may have seasonally grown crops in the lower reaches of the Casma Valley, using this method of farming.

By late preceramic times experimentation with canals was probably well underway, and this latter event soon gave rise to full scale irrigation farming. The existence of irrigation agriculture dating to the Initial Period has been postulated for the Moche Valley on the Peruvian north coast. Since midden deposits in both inland and coastal sites in the Moche Valley are a mixture of terrestrial and marine resources, it would appear that the crops grown under irrigation in the interior regions of this valley were regularly exchanged for ocean products which formed the economy of the downstream, coastal sites. A similar situation is believed to have existed with respect to the inland and coastal communities of the Casma Valley during Initial Period times. Here, evidence from middens points to Pampa de las Llamas-Moxeke and Tortugas as one such pair of symbiotic communities.

With regard to size, the sweet potato roots examined here are generally well within the range of other archaeological specimens of this crop taken from other sites. Yen (1974), for example, describes and illustrated a 10,000 year-old root of the sweet potato from Chilca Canyon which has a length of about 3 inches, or 76 mm. Similarly, a root of this crop collected by Ugent at Pachacamac in 1973 has a length of 60 mm. Starch grains (Fig. 5E) from this 1,000 year-old root are similar to ones found in the Casma series, and both fall within the range of variation of the starch drawn from the modern sweet potato (Fig. 5H).

The small size of the Casma roots as compared to the modern sample of the sweet potato shown in Fig. 5I, however, is another matter. The largest unbroken root from the three Casma sites examined here is only 31 mm long. However, one fragment (Fig. 2H) is 40 mm long and appears to represent about one-half of the original root. These dried samples, it should be remembered, have shrivelled to about one-half their original size, and have probably lost about 90% of their fresh weight.

While important, shrinkage is probably not the only factor which accounts for the smaller size of the ancient roots. It is possible that only the larger roots at the three Casma sites were eaten, whereas the smaller ones found their way into the midden heaps. Also, it must be remembered that the sweet potato has now undergone an additional 3800 years of artificial selections by man since its first known appearance in the Casma Valley.

Finally, it must be mentioned that the occurrence of charcoal fragments in the skin and interior cavities of the Casma sweet potato roots suggest that these were probably originally prepared by baking, perhaps by placement along the edge of an open camp fire. This method of preparation would appear to be especially logical for Huaynuma, as it is a preceramic site.

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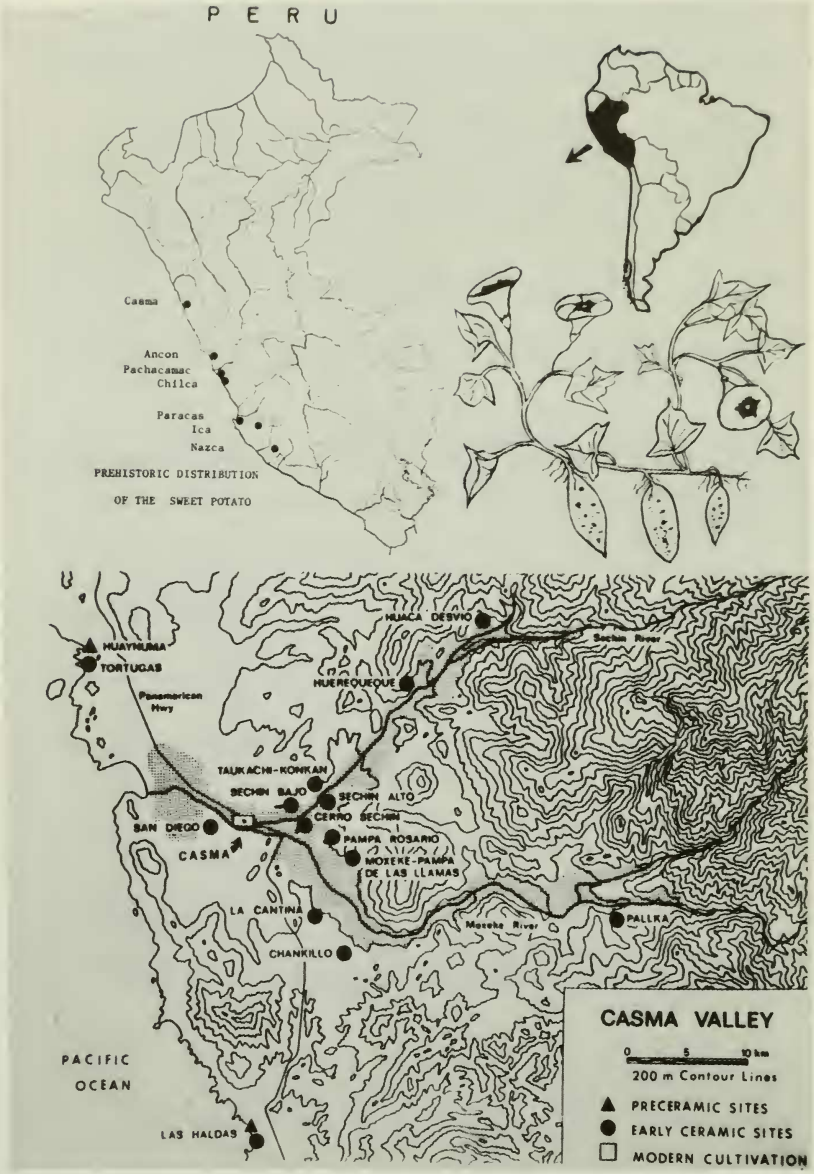


Figure 1. Past distribution of the sweet potato and location of the Casma Valley archaeological sites mentioned in the text.

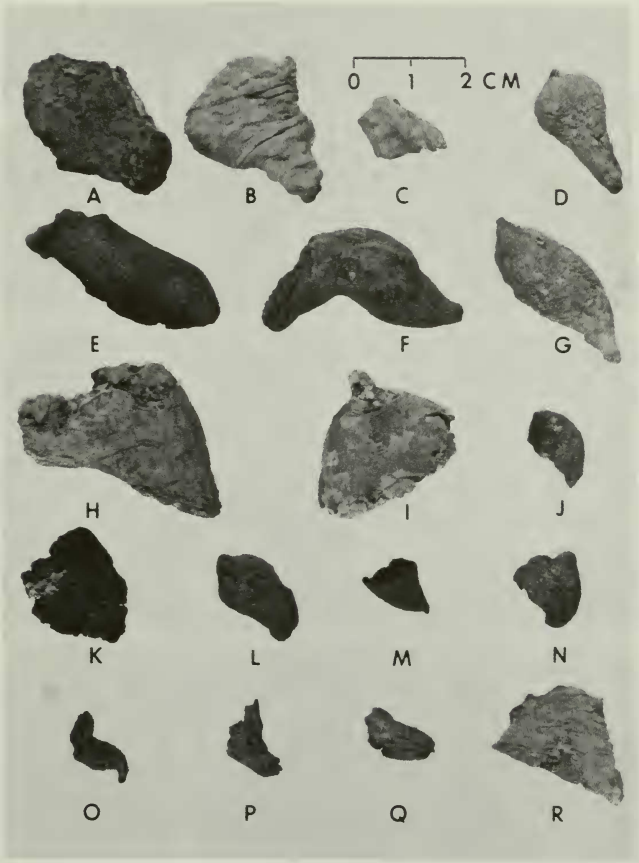


Fig. 2. Sweet potato remains from three archaeological sites in the vicinity of Casma, Peru. A-I. Root samples from Pampa de las Llamas-Moxeke. J. Specimen from Huaynuma. K-R. Collections from Tortugas.

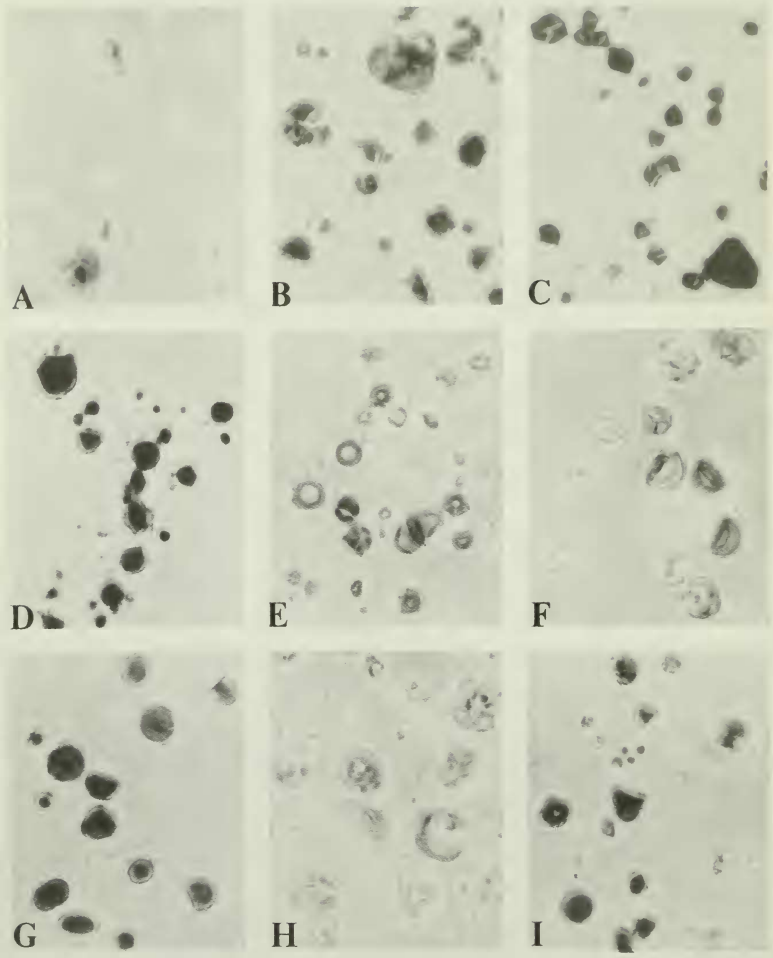


Fig. 3. Iodine-stained starch granules of preserved sweet potato roots (all phase contrast and 250 X). Refer to corresponding legends in text and in Figure 2 for further information.

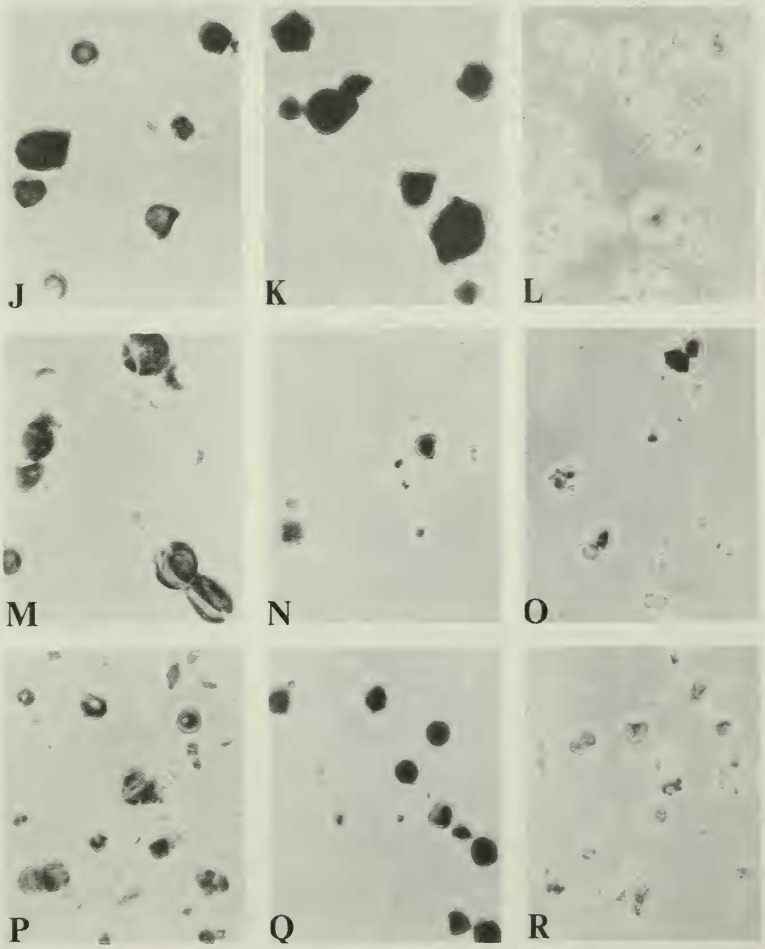
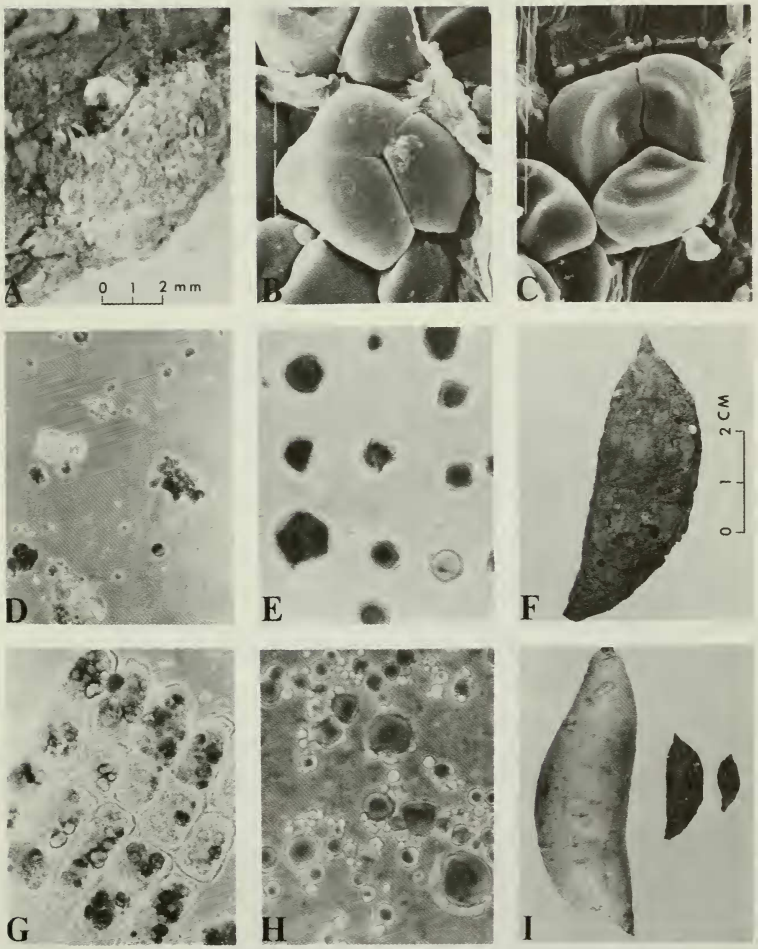


Fig. 4. Iodine-stained starch granules of preserved sweet potato roots (all phase contrast and 250 X). Refer to corresponding legends in text and in Figure 2 for further information.

Fig. 5. Illustrations of sweet potato cited in text. A. Broken cortical end of Tortugas root fragment (specimen 11), this showing curved, crystalline strand of water-soluble material arising from underside of skin. B. Scanning electron micrograph of compound starch grains from specimen 3, Pampas de las Llamas-Moxeke collection (gold-palladium coated, 2000 X). C. The same, but showing one of the grains lacking several of its smaller pieces, or granules. D. Fragment of xylem vessel and iodine-stained starch granules from the single Huaynuma root, specimen 10 (phase contrast, 160 X). E. Iodine-stained granules of a preserved root found at Pachacamac by Ugent (micrograph in phase contrast and at 250 X). F. Root from Pachacamac used in previously cited starch preparation. G. Iodine-stained starch grains in the cells of a freshly-grown sweet potato (phase contrast, 160 X). H. Iodine-stained starch granules of the modern sweet potato (phase contrast, 250 X). I. A fresh, medium-size (17 cm) root of the sweet potato as compared to archaeological samples from Pachacamac (center) and specimen 7 from Pampa de las Llamas-Moxeke (right).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